

ABSTRACT
(1 page only)

TITLE OF THE PAPER:

The Russian International Phobos Sample Return Mission

AUTHOR and CO-AUTHORS:

A. A. Galeev, V. I. Moroz, A. V. Zakharov, R. S. Kremnev, B. N. Martynov,
O. V. Papkov, T. C. Duxbury, Yu. A. Surkov, E. L. Akim, and M. Marov

DESCRIPTION: (should clearly present the purpose of your paper and include detailed information on the methods and results of your research)

Opportunities exist to launch a PHOBOS spacecraft using a PROTON launch vehicle in either 1998-99 or 2003 to go to Mars and bring back a sample from the surface of Phobos, the inner moon of Mars. A sample arm and Earth Return Vehicle would replace the Mars Surface Penetrators, Small Stations, Rover and Balloon being carried by the PHOBOS spacecraft on the Russian International Mars 94 and Mars 96 missions for the Phobos Sample Return Mission. Also some of the Mars remote sensing science instruments, and pointing platforms would be removed and replaced with Phobos specific remote and in-situ science instruments.

The Phobos Sample Return Mission is not only of the highest scientific importance for the return of a sample but provides an early testbed for the technology development needed to support a Mars Sample Return Mission and Mars Human Exploration. The Phobos mission can be flown earlier and easier because Phobos does not have the large gravity and atmosphere of Mars to contend with for landing and departure. The analyses of a Phobos sample, expected to be about 1 kg, returned to earth will undergo the most complex and widely varying laboratory investigations which would be unlimited as compared to what can be done in-situ, as was the case for the Lunar samples.

Such a mission would take 8-9 months from Earth to Mars, would stay in the Mars / Phobos vicinity performing remote observation, Phobos landing, sample acquisition and Mars de-orbit for 10-14 months, and would return to Earth in 7-18 months giving a mission lifetime of 2.7-3.3 years. Many Mars orbiting and Phobos rendezvous, landing and de-orbit trajectory options exist to accommodate a large range of Mars and Phobos science objectives.

The Earth Return Vehicle could either re-orbit Earth upon return or have a direct entry to the surface of Earth saving much weight in the design of the return vehicle and giving the mission more flexibility and fuel margin. If an Earth re-orbit vehicle is used, then sample acquisition at earth would be performed by either a MIR or Shuttle pickup. Also, the use of aerocapture at Mars would significantly increase the scientific and engineering payload delivered into Mars orbit and to the Phobos surface.

The suite of scientific instruments could include: solar plasma and high energy particle detection during the Earth-Mars trajectory leg; remote visual, IR, UV, Gamma Ray and magnetometer instruments for Mars and Phobos surface observations and particle detectors while in Mars / Phobos orbit; and a sample arm, temperature probe, alpha-gamma-neutron-proton spectrometers, seismometer and a gas analyser in-situ instruments for in-situ observation on Phobos. The PHOBOS spacecraft would remain on the surface of Phobos for continued surface observations as well as providing a radio link to Earth for Mars, Phobos and Solar System orbital dynamics studies long after the return vehicle departs.

The 1998-99 launch opportunity is marginal with the current PROTON and would require the implementation of a new PROTON upper stage, the use of a direct entry Earth Return Vehicle or possibly the use of aerocapture at Mars. The limited time to develop and demonstrate such technologies before this launch date makes this launch opportunity questionable. The 2001 launch window to Mars requires such an excessive amount of launch energy that it cannot be considered without requiring aerocapture at Mars. However, the launch energy needed for the 2003 launch window is sufficiently low to fly the mission with the current PROTON and without aerocapture or a direct entry Earth Return Vehicle if desired.

Therefore, a serious study will begin to design a Phobos Sample Return Mission for the 2003 launch opportunity. As with the previous Russian International 1988 PHOBOS, the Mars 94 and the Mars 96 Missions, it is expected that this mission will also have significant international cooperation from the CIS Republics, Europe, the US and Japan.